A Prototype Remote Sensing Validation Site: Towards a Multi-Variable Approach to Validating and Scaling Remotely-Sensed Observations of the Water Cycle

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Hypotheses:
1) remotely-sensed observations of the water cycle can best be validated through the use of a rigorous statistical methodology that accounts for variability in the data (including ancillary data) at a variety of space and time scales; and 2) integrating other hydrologic processes and related environmental variables (i.e. a complete water cycle experiment) to better constrain the specific hydrologic variable of interest is a powerful validation method that has yet to be fully exploited because of the lack of complete, high-quality,and long-term data.

Objective: small (1 km^2) prototype experimental validation site heavily instrumented with both in-situ and remote sensors.
Deliverable: process-scale data instantly available via wireless technologies and internet.
Deliverable: joint (in space and time) distribution of errors for observations.

A Remote Sensing Observatory for Hydrologic Sciences: A Genesis for Scaling to Continental Hydrology

Submitted to *Water Resources Research*

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"A casual look from an airplane window reveals a landscape that is highly heterogeneous..."

"Remote sensing offers the only observational tools that have the potential to capture these spatial patterns..."

"It is questionable whether remote sensing will provide measurements suitable for subsequently derived hydrologic products with sufficient accuracy to be useful for scientific studies in hydrology..."

How do we convert data that represents one particular time or space scale to another scale for comparison with other information?

How does sampling at a given scale affect the estimation of the average quantity?

How significant is the location of the sensor in a heterogeneous environment when attempting to estimate average quantities?

What is the adequate sample size to reach a statistically sound conclusion?

What are the underlying models of space-time variability?

Are the processes scale invariant? Is there a characteristic scale?

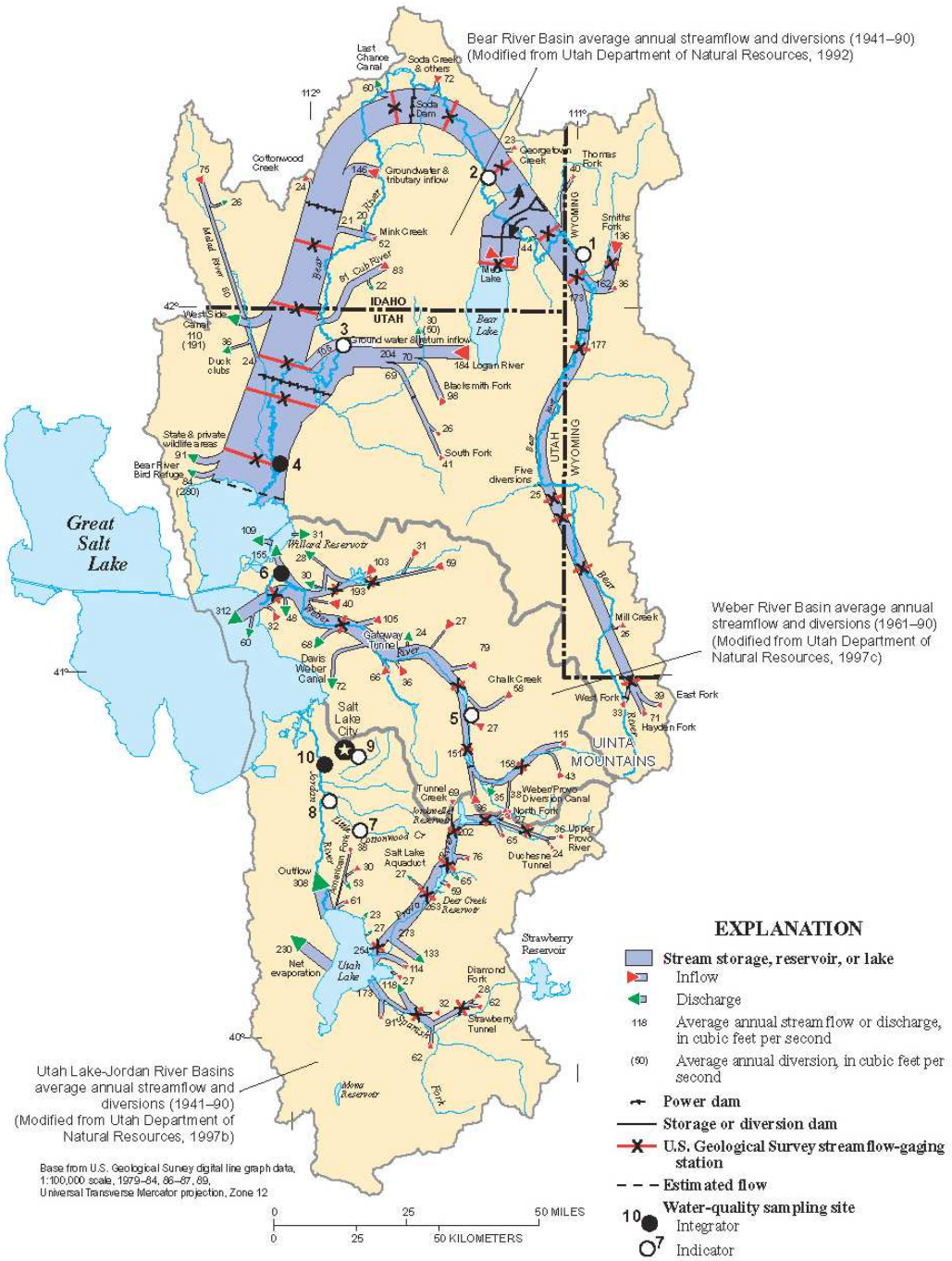
What are the error bars?

What NEWS needs.

Complete water cycle measurements
at one point in time
(bedrock to boundary layer).

Year round data.

Applicable to the global scale.



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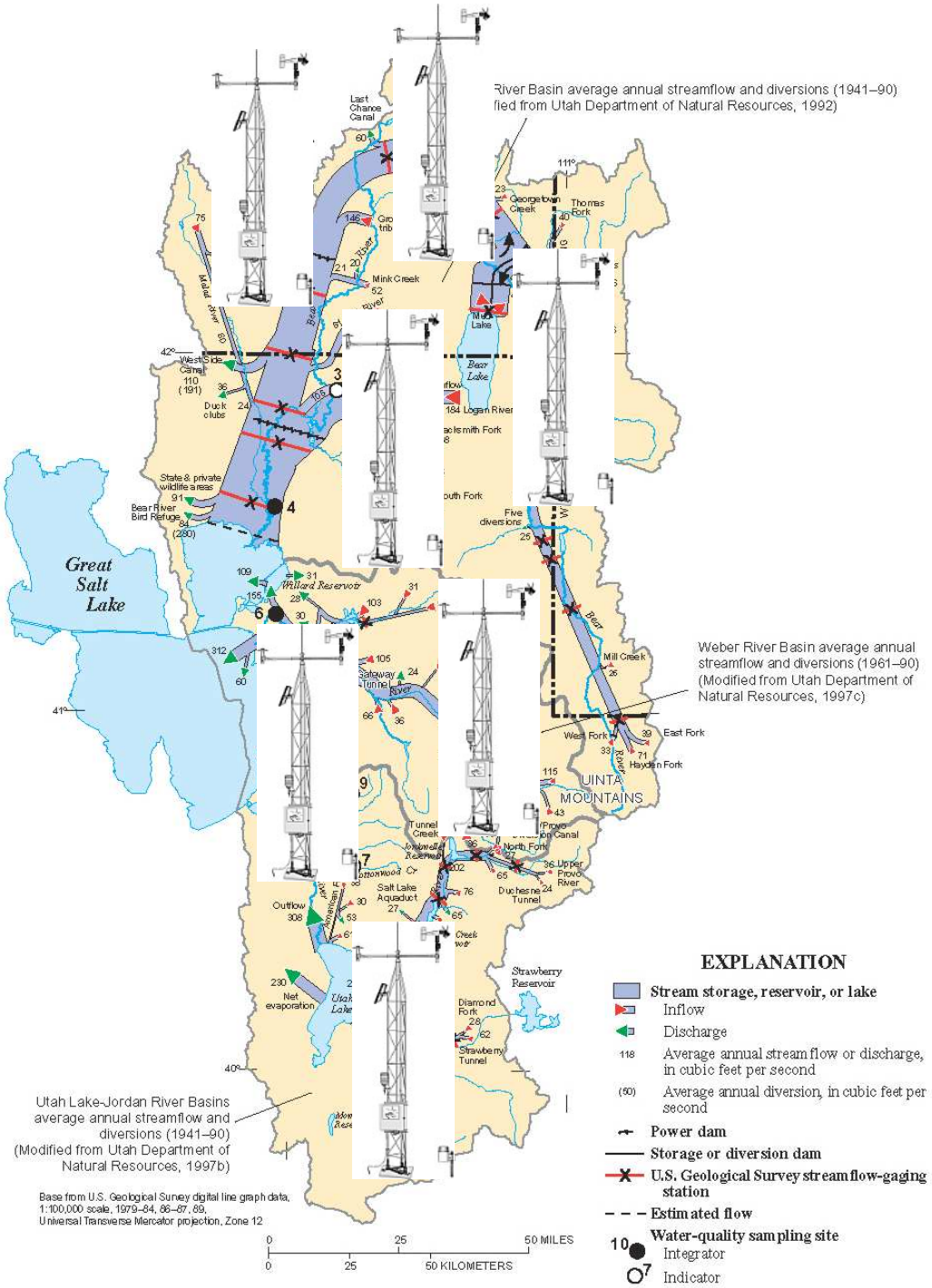

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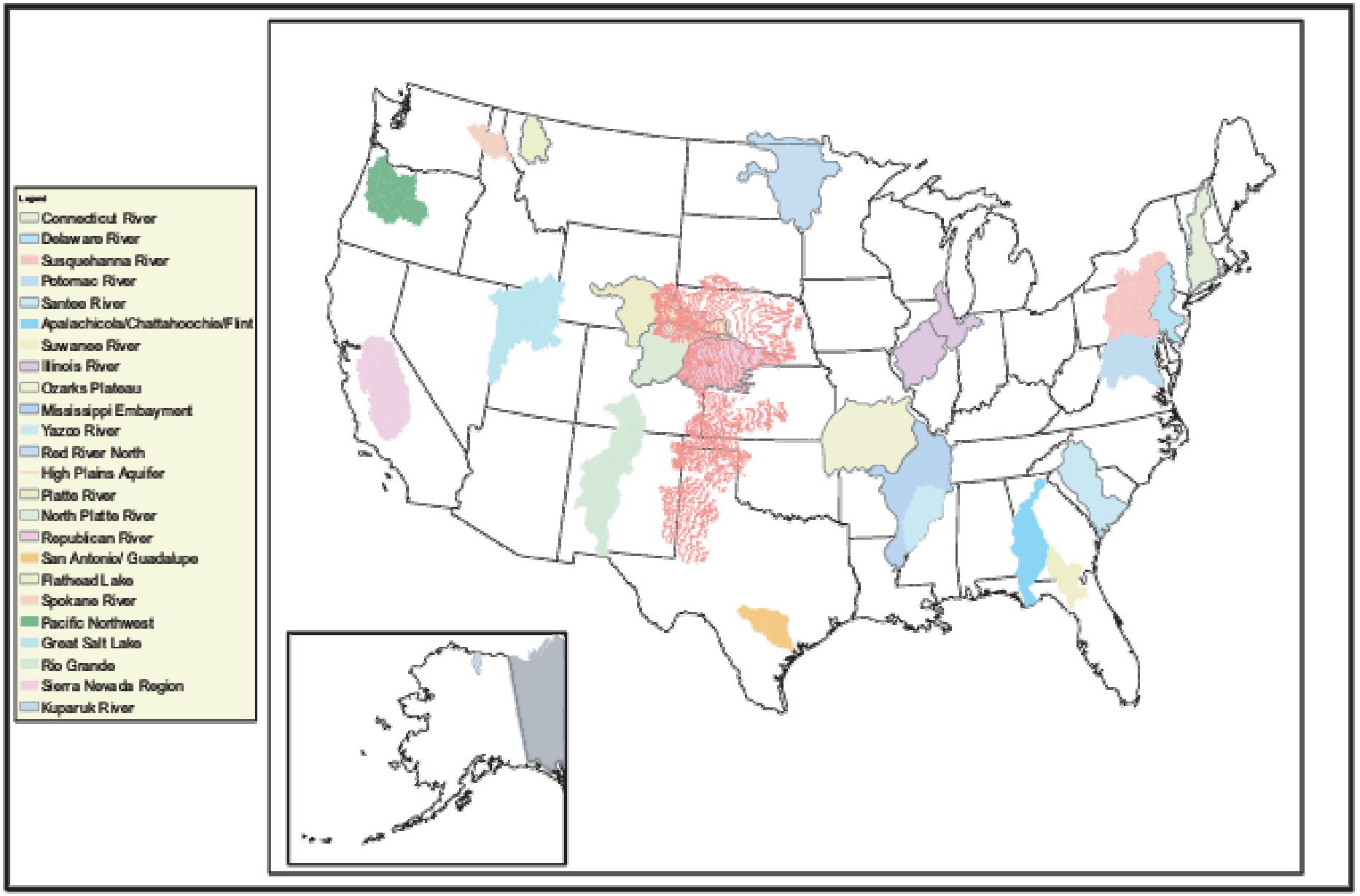


What NEWS needs.

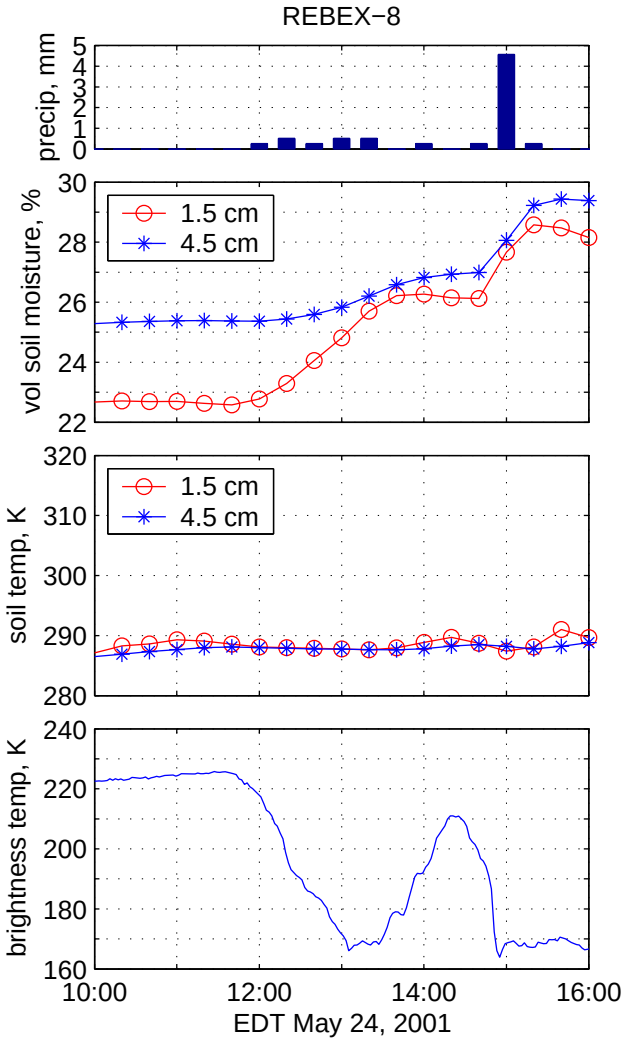
Can this be done now? *No.*

Can this be done in the future?

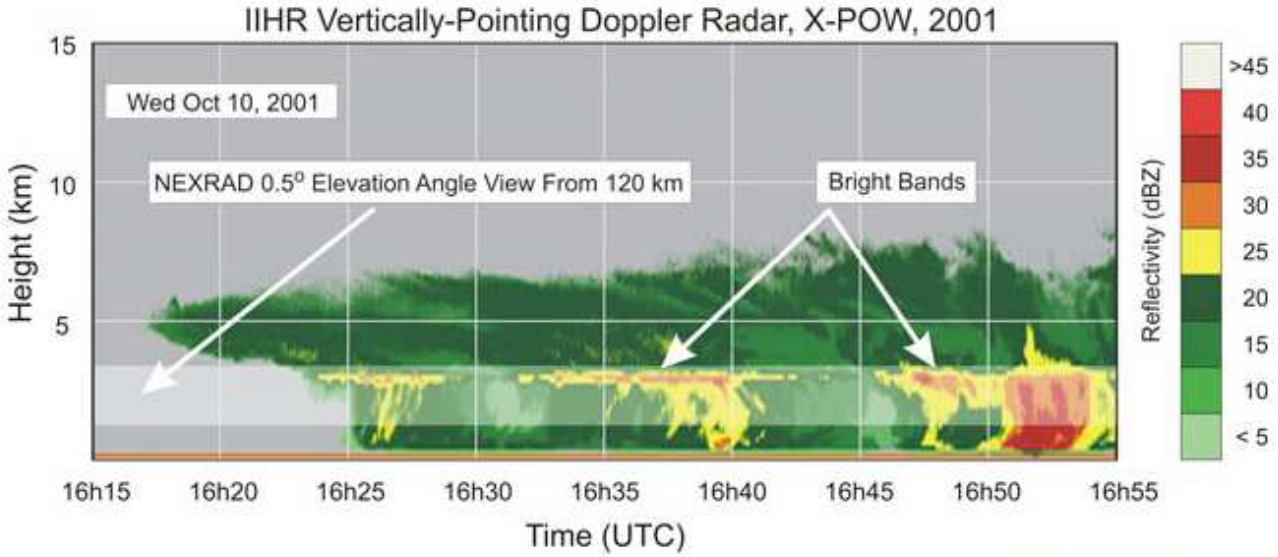
What can we do now? Where do we start?

Upcoming soil moisture missions:

Hornbuckle (ISU): soil moisture remote sensing.

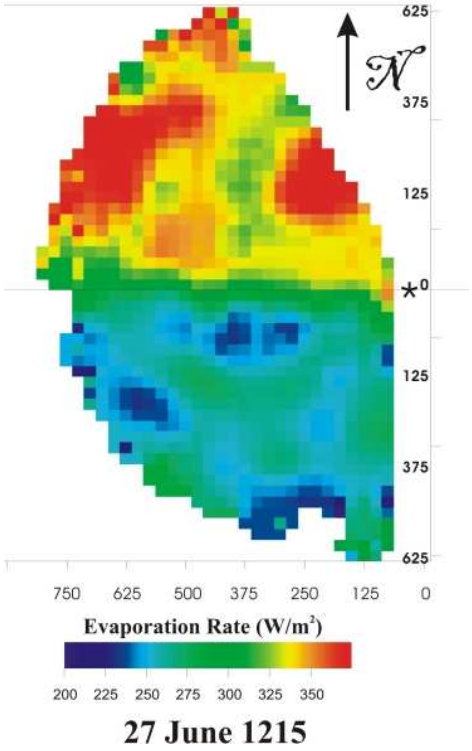


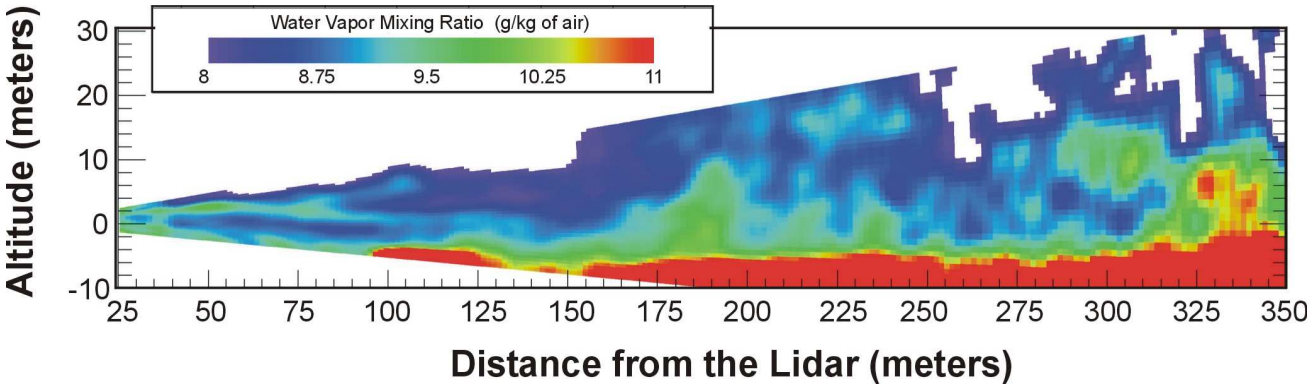
Krajewski (UI): remote sensing of precipitation.



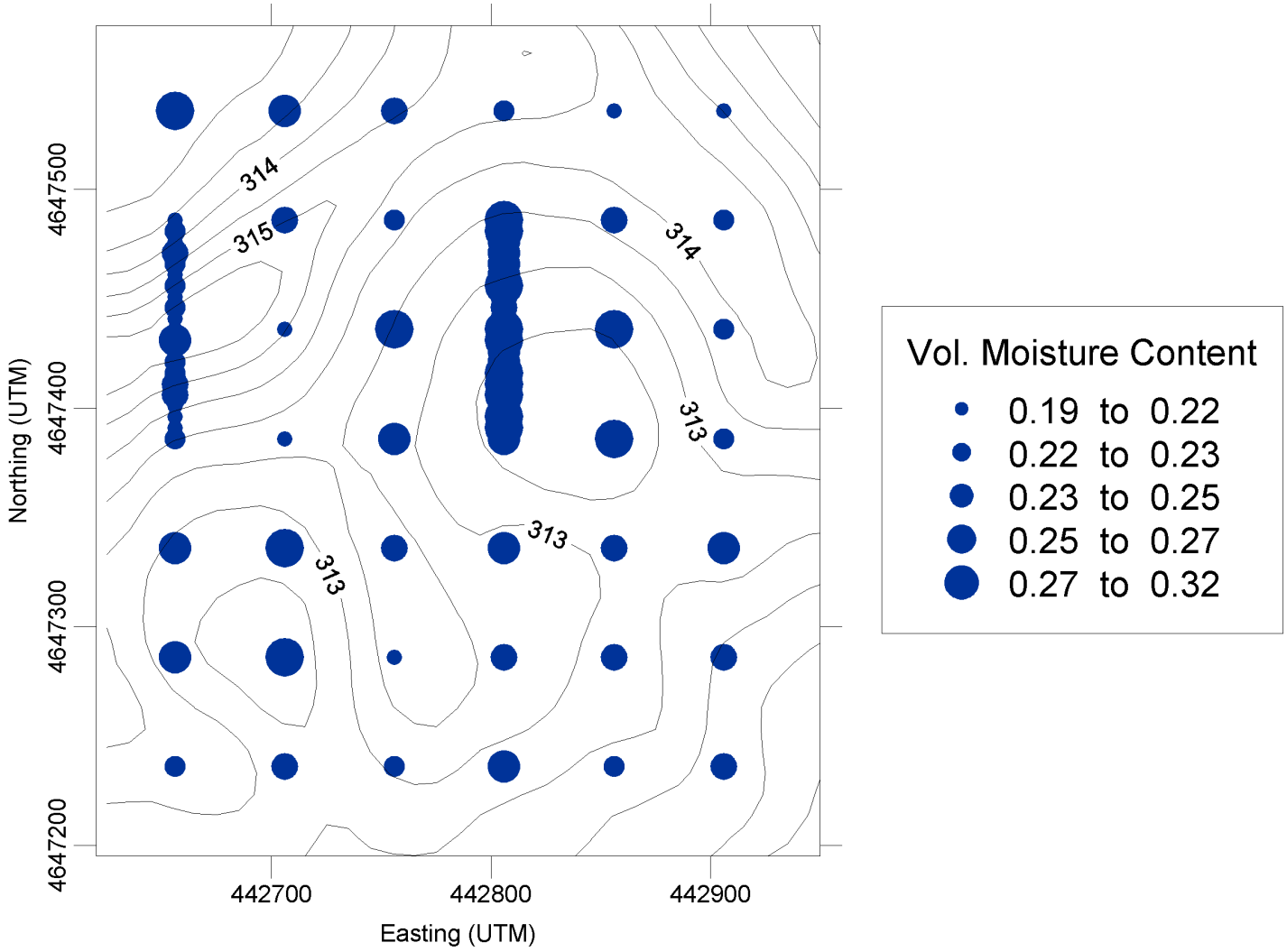
Example of data collected with IIHR's Vertically Pointing Radar. The bright bands at a height of about 2.5 km are clearly visible.

Eichinger (UI): remote sensing of evapotranspiration.



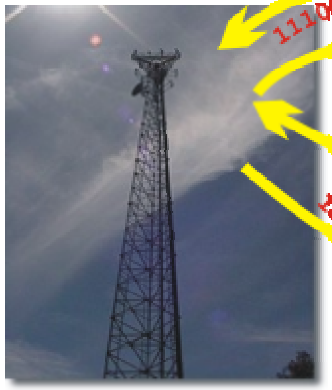


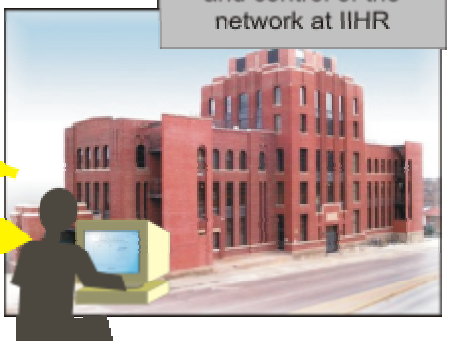
Kaleita (ISU): soil moisture variability.

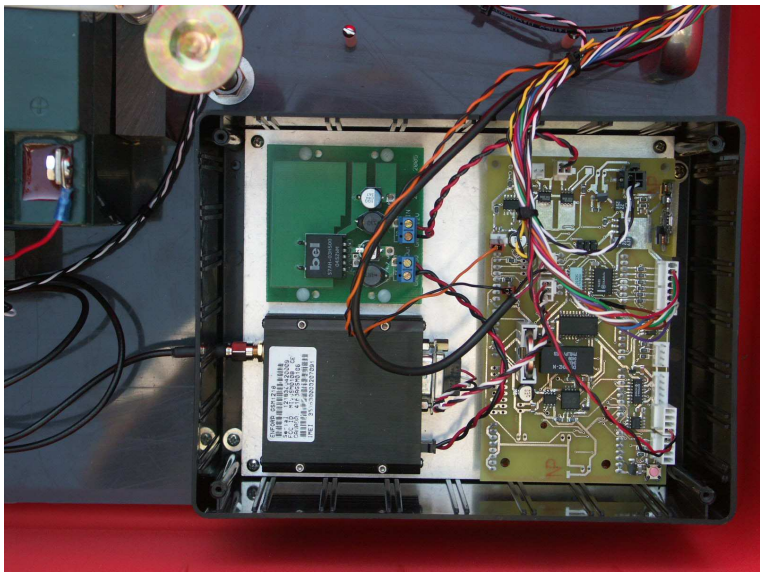


Kruger (UI): wireless technologies.

- True network
- Adaptive
- Accurate time stamp
- Non-intrusive
- Open architecture







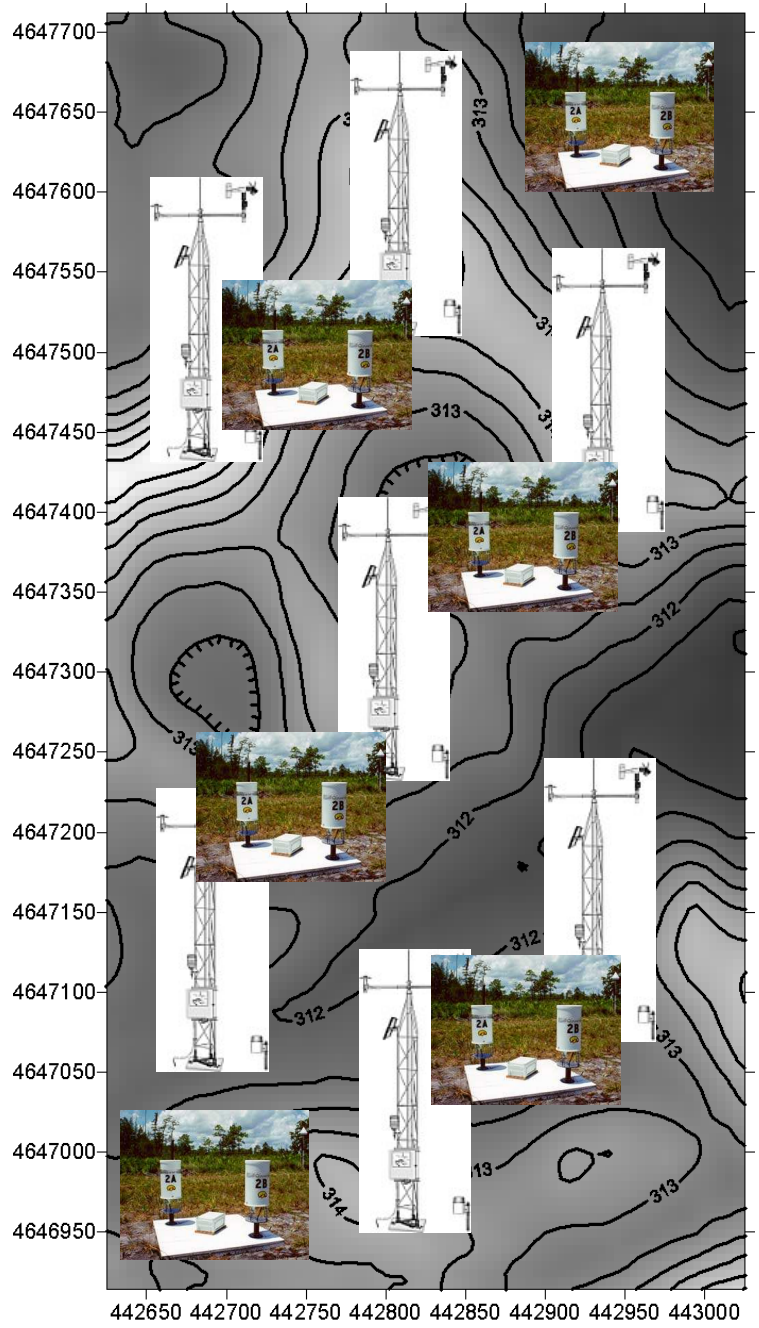
prototype validation site

year-round observations in Iowa
- Koster “hot spot”
- varying biomass
- relatively homogeneous
- both rain and snow

soil moisture, precipitation, sensible and latent heat fluxes, groundwater, stream/tile flow

10-day yearly intensives
- remotely-sensed soil moisture and evapotranspiration
- summer, fall, winter, spring

available in real-time



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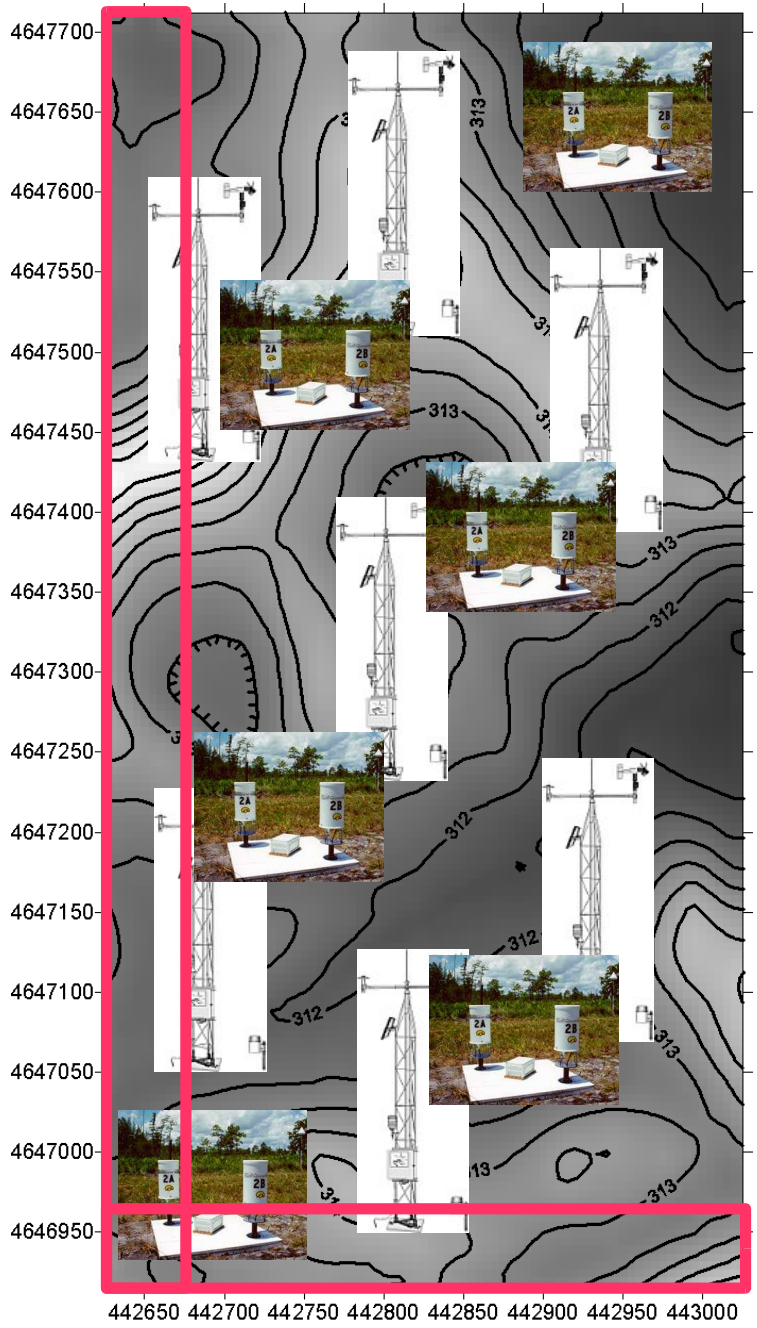

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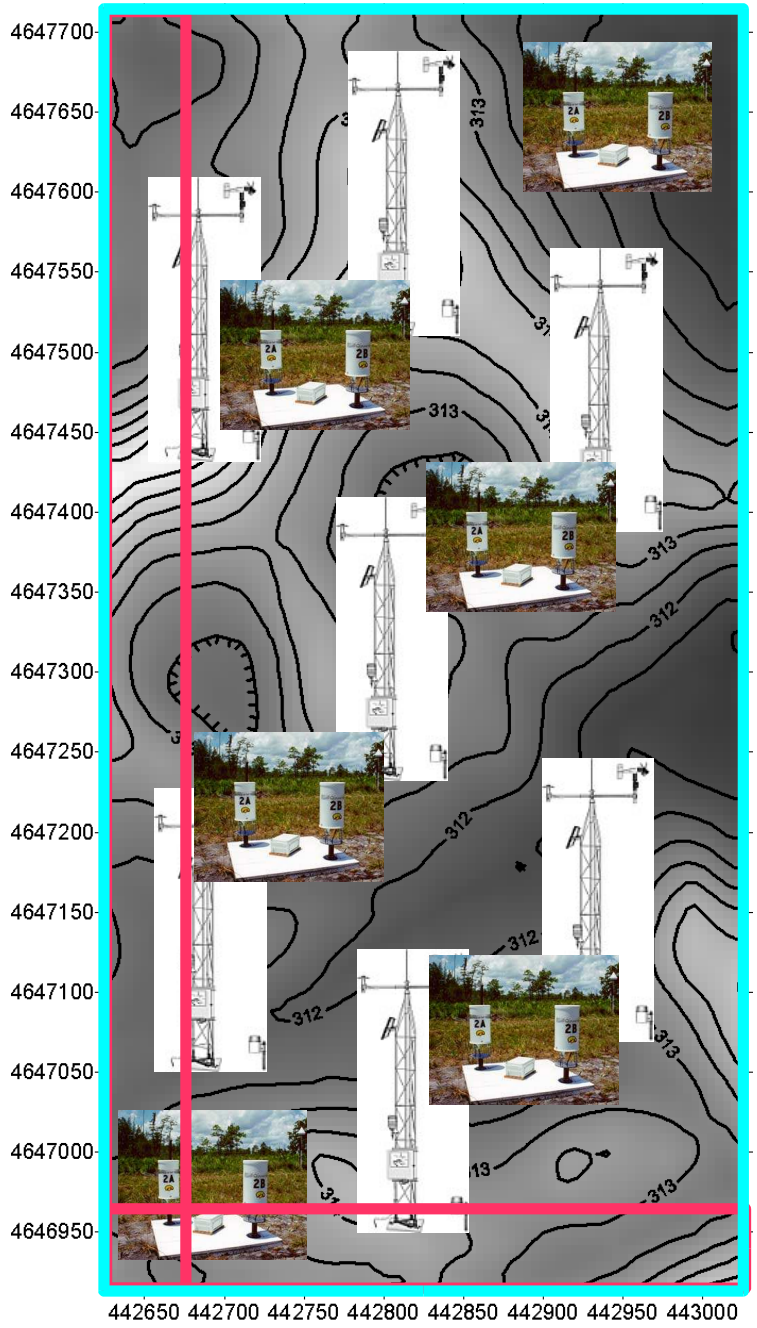

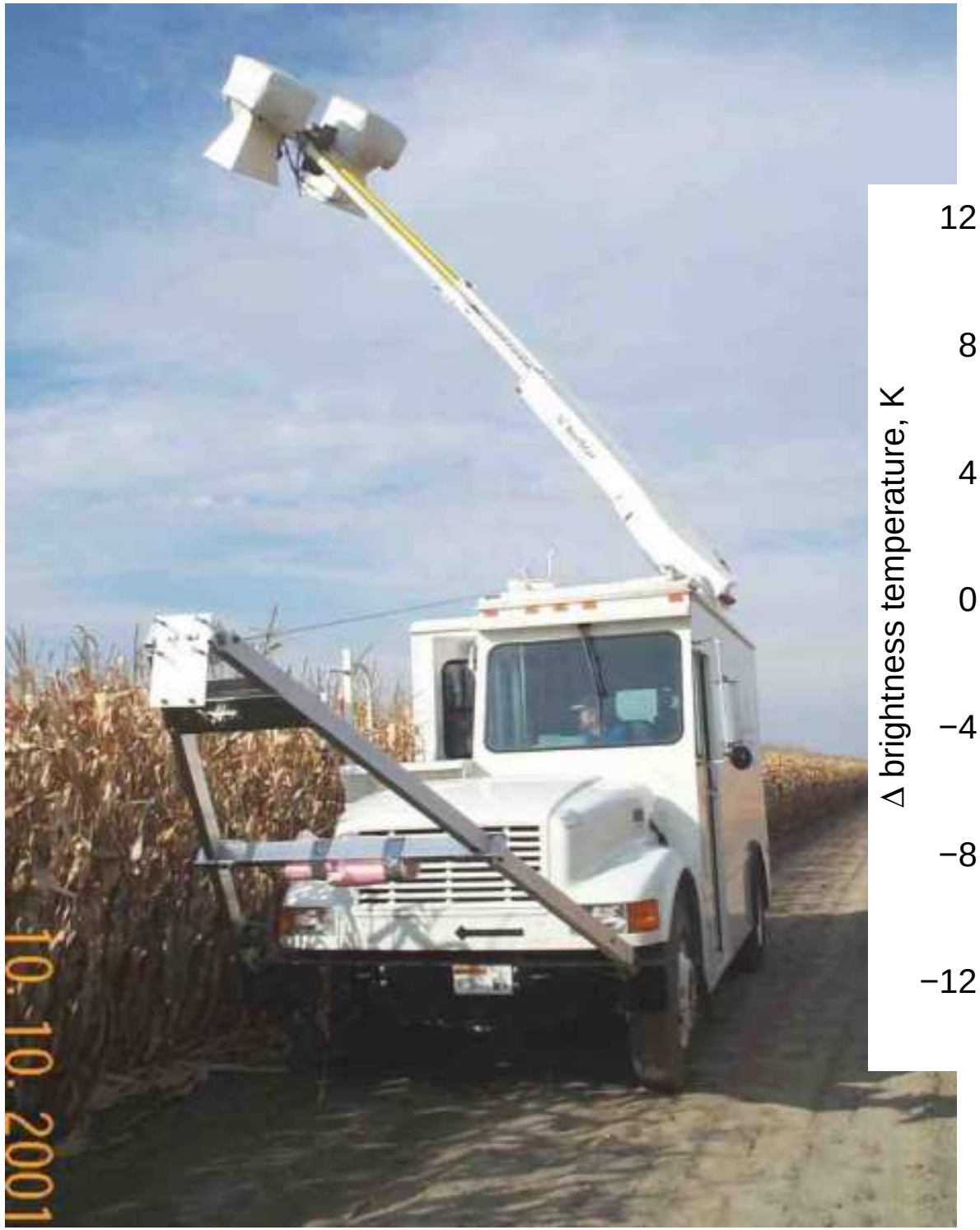
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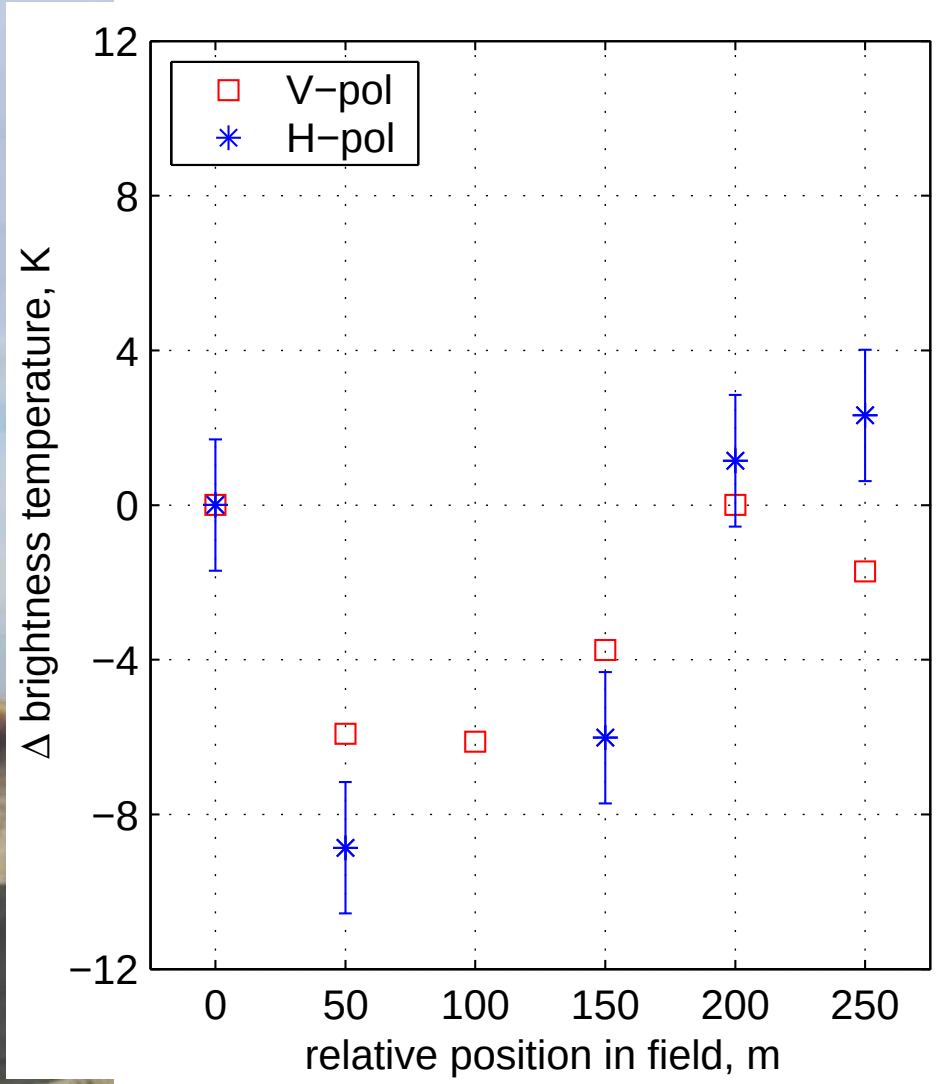
V−pol
H−pol
Δ brightness temperature, K
relative position in field, m
12
8
4
0
−4
−8
−12
0
50
100
150
200
250

Data set needs

NASA products of appropriate resolution (LIS, MODIS)

Project outputs

data to determine scaling issues

error characterization of remotely-sensed soil moisture

validation of LIS, MODIS, precipitation ...

statistical methodology to validate remotely-sensed observations

Potential collaboration

Koster, Peters-Lidard/Tao, Rodell, Denning, Sorooshian, Adler, Reichle, Curry

Important outside linkages

extensive USDA ARS infrastructure in region

SMOS and Hydros (Hornbuckle)

CUAHSI (Krajewski and Kruger)

Expected contribution to NEWS objective

Understanding / assessment:
Increase the value of NASA observations by quantifying the associated errors.
Provide a method for direct comparison of data from disparate sources.

Understanding / synthesis:
Combine observations of soil moisture, precipitation, and evapotranspiration to better quantify each component.

Issues, needs, concerns